Anaerobic Digestion Technology in the U.S. Livestock Industry

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What are Anaerobic Digesters?

Biological treatment/stabilization systems that collect and combust off-gases

Digesters separate manure treatment from storage functions which can result in lower initial installation costs for new or expanding farms

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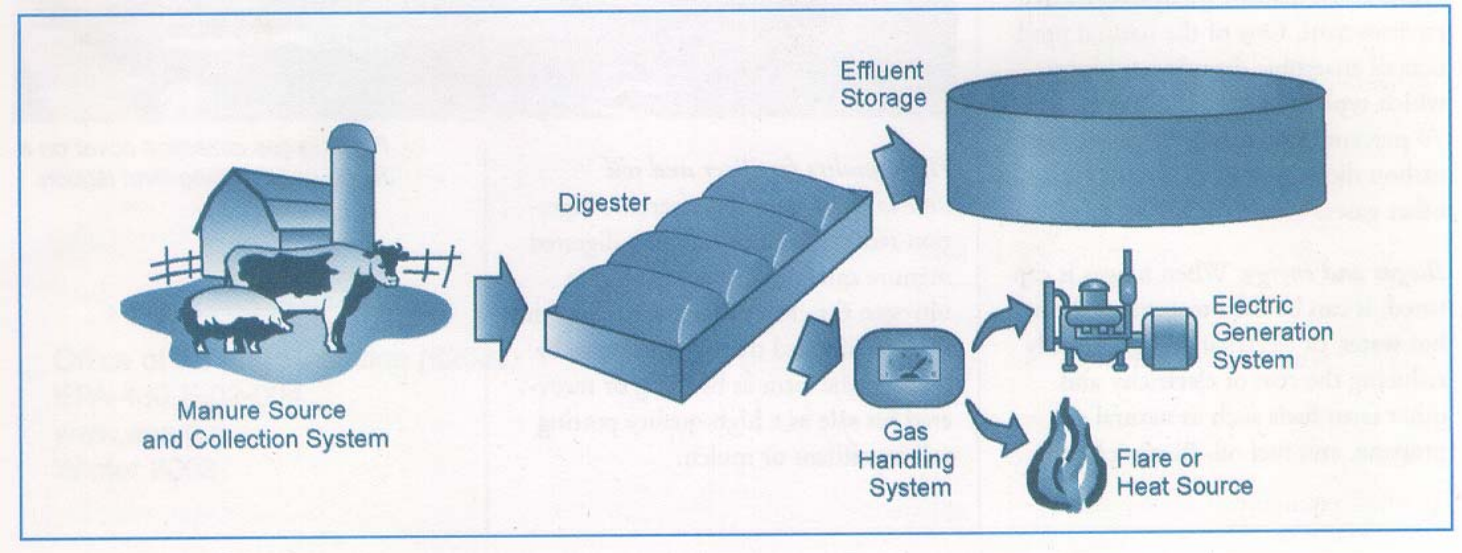
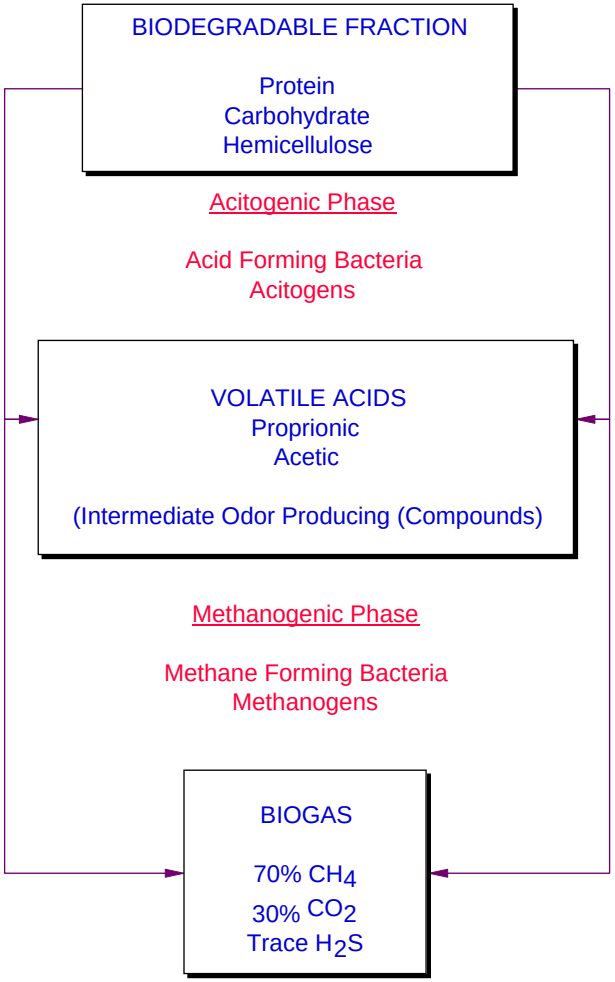


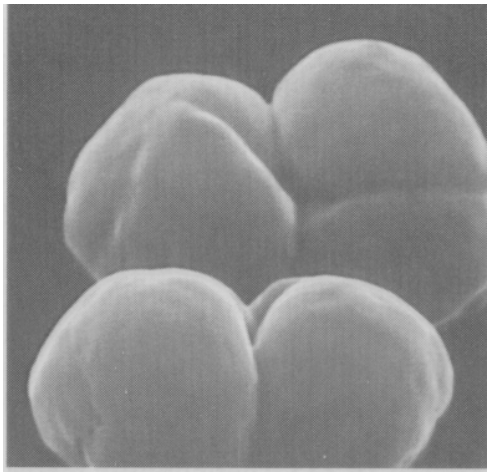
What Makes Digesters work

Anaerobic digestion is a biological process. It occurs in an oxygen free environment.

Temperature and time control reaction rates

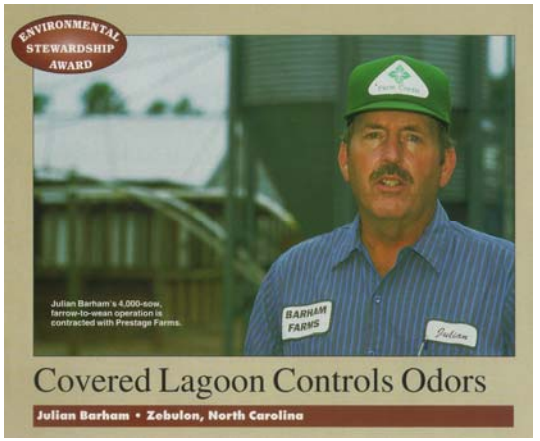


Methanogens



Industry Interest in Anaerobic Digestion Technologies

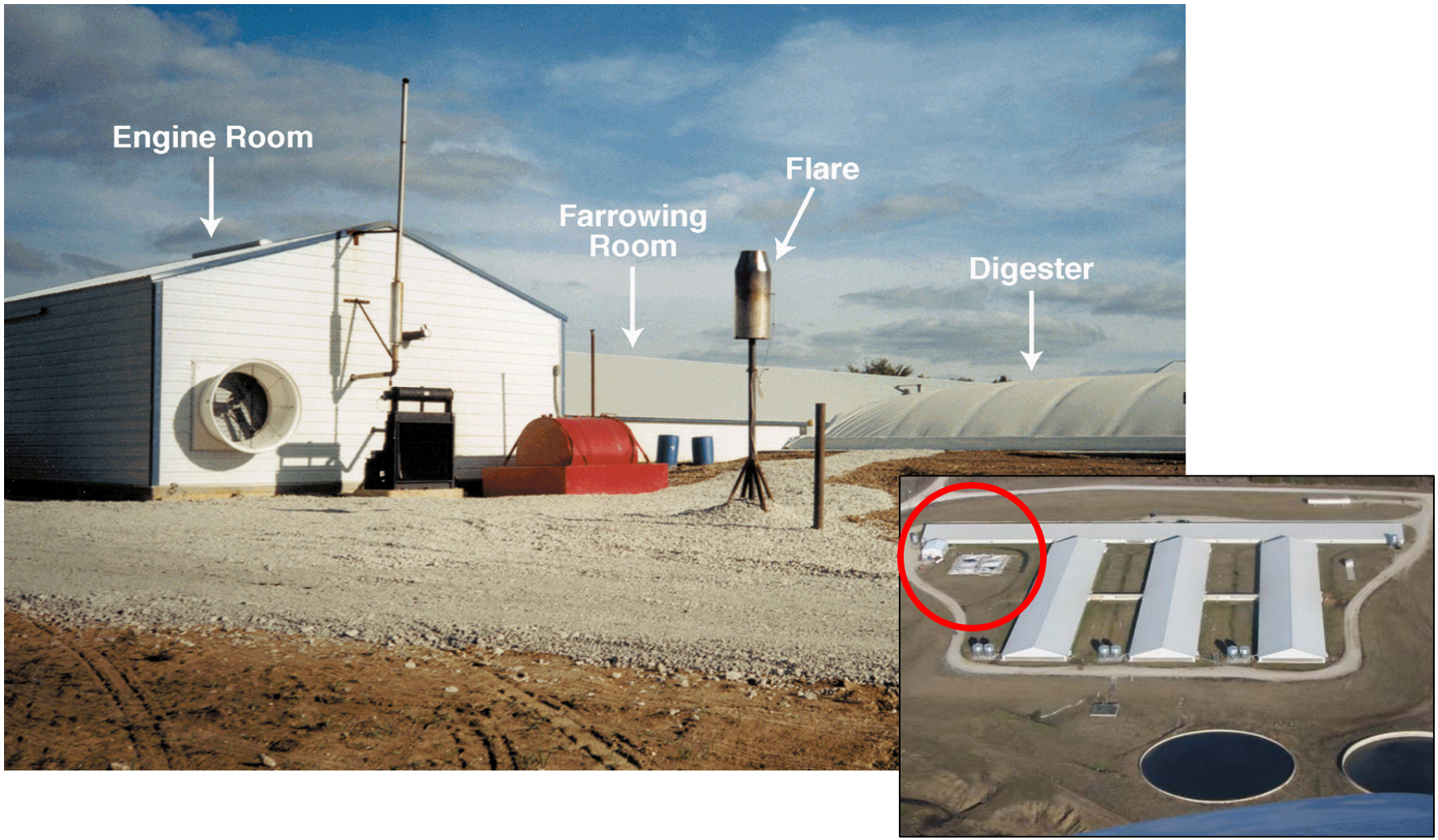
1) Offer Air Quality benefits
   - -Control odors from storage and field application
   - -Reduces Greenhouse gases (methane)
   - -Controls other emissions (H_2S, VOC)



2) Offer Water Quality benefits
   - -Stabilize manure organics (BOD)
   - -Significantly reduce pathogens
   - -Provide nutrient management predictability and flexibility

3) Offer return on Investment
   - -Energy revenues
   - -Carbon Markets
   - -Greenhouse Production
   - -Peat market (dairy only)
   - -Bedding offsets (dairy only)

Typical Digester Configuration



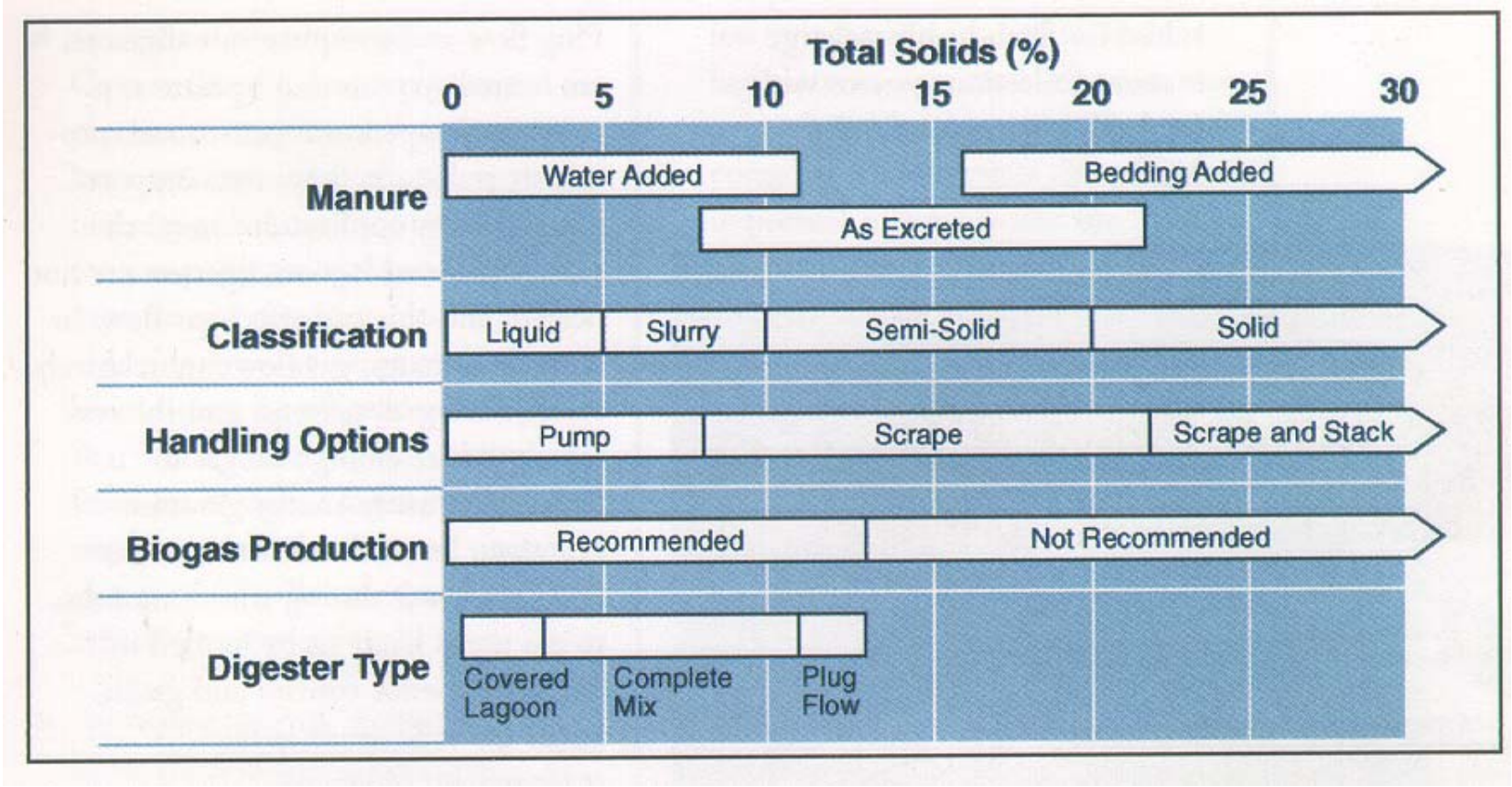
Environmental Retrofit

Retrofit Plan

Before

After

Digester Selection

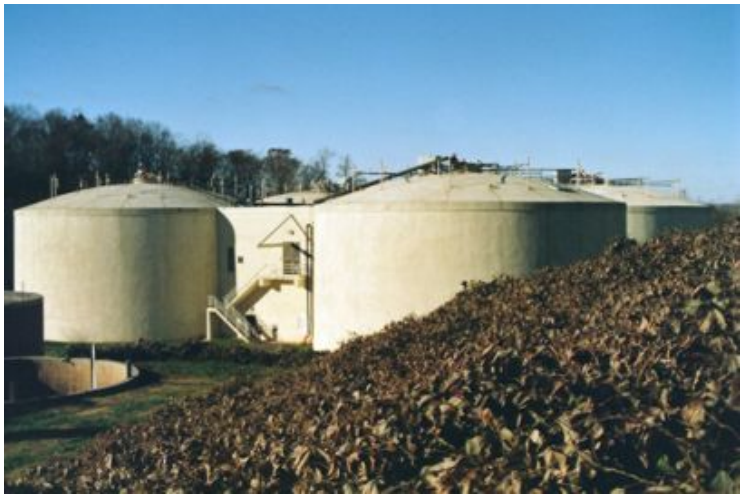


Project Types: On-farm

- On-Farm: System is owned and operated by farm owner/manager
  - Currently the predominant project type in the U.S.
  - Some co-digest higher value organics
    - Cheese whey
    - Ice cream
    - Greases/oils

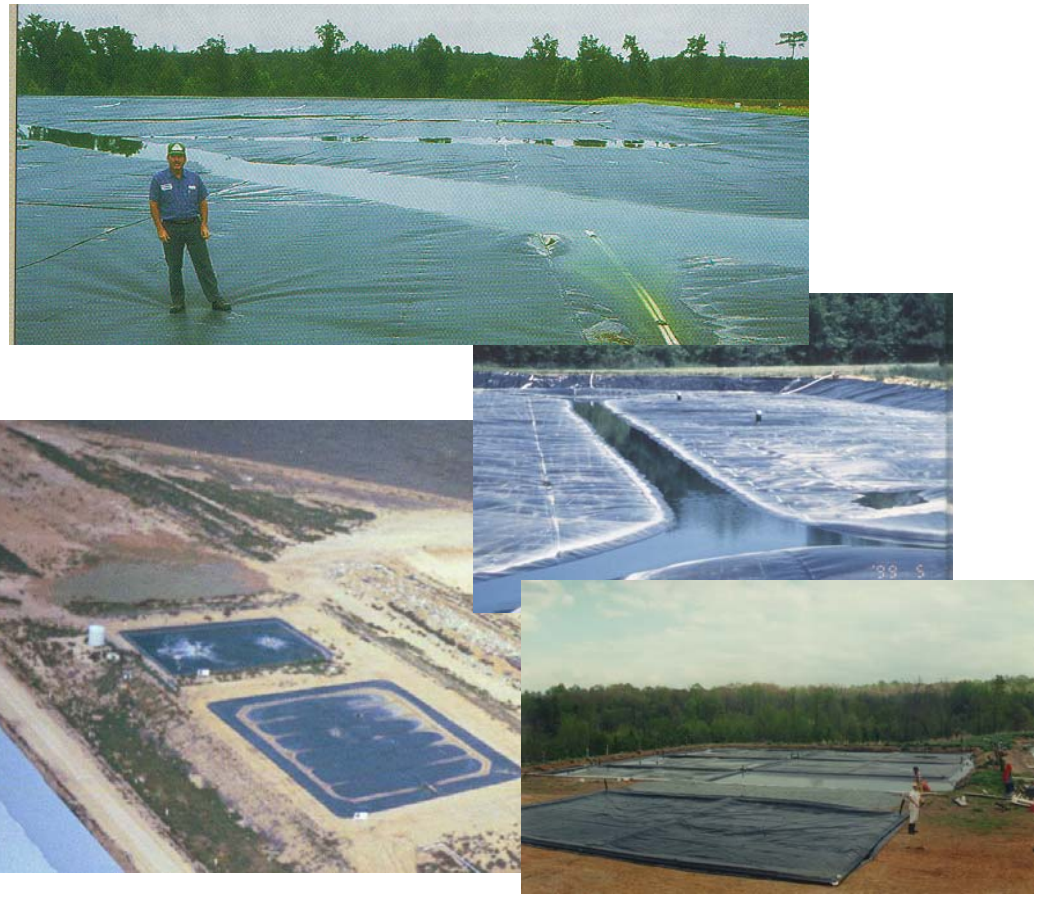
Project Types: Centralized

- Regional or Centralized Digesters: Off farm management and operation with a third party
  - Ideally located at a large energy (electric or heat) consuming source or interconnection point (feed mills or utility substation)
  - Currently two operating on Dairy waste on west coast
  - Can also include co-digestion



Unheated Digesters

Covered Lagoons



Attached Media

Heated Mixed Digesters

Heated Plug Flow Digesters

Used for Dairy only w/ Separation

Gas Use: Electrical Generation

Recip. Engines 40-250kW

COMPONENTS

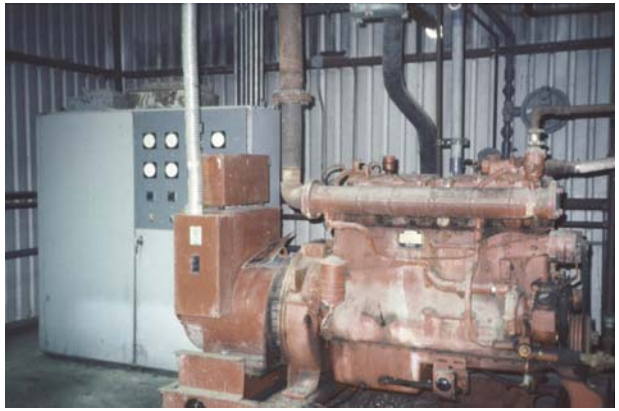
Gas Handling

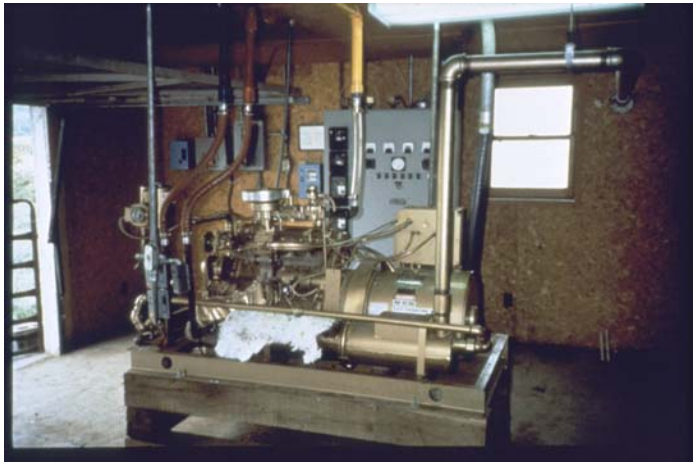
Engine Controller

Electric Metering

Gas Use: Electric

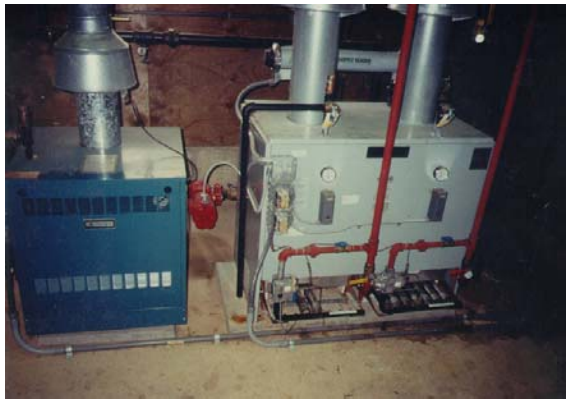
More Engines



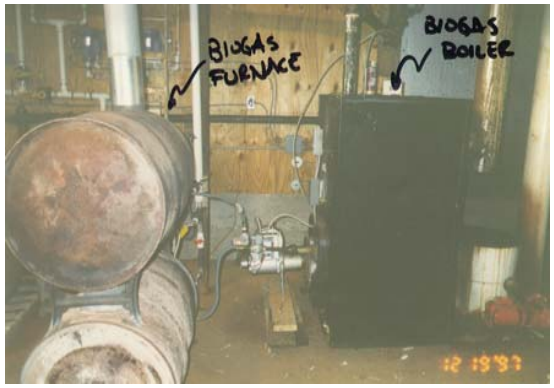


Gas Use: Heat

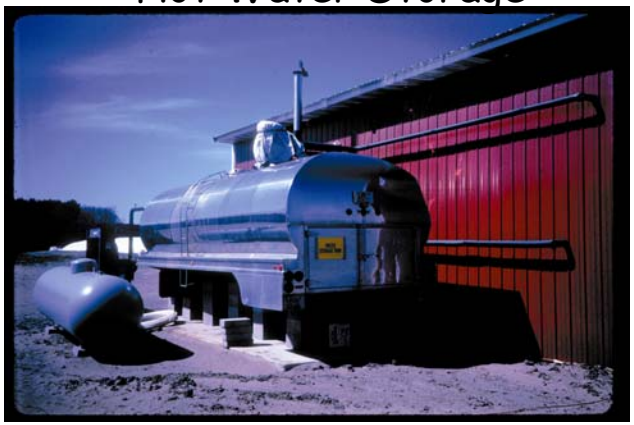
Boilers



Forced Air



Hot Water Storage



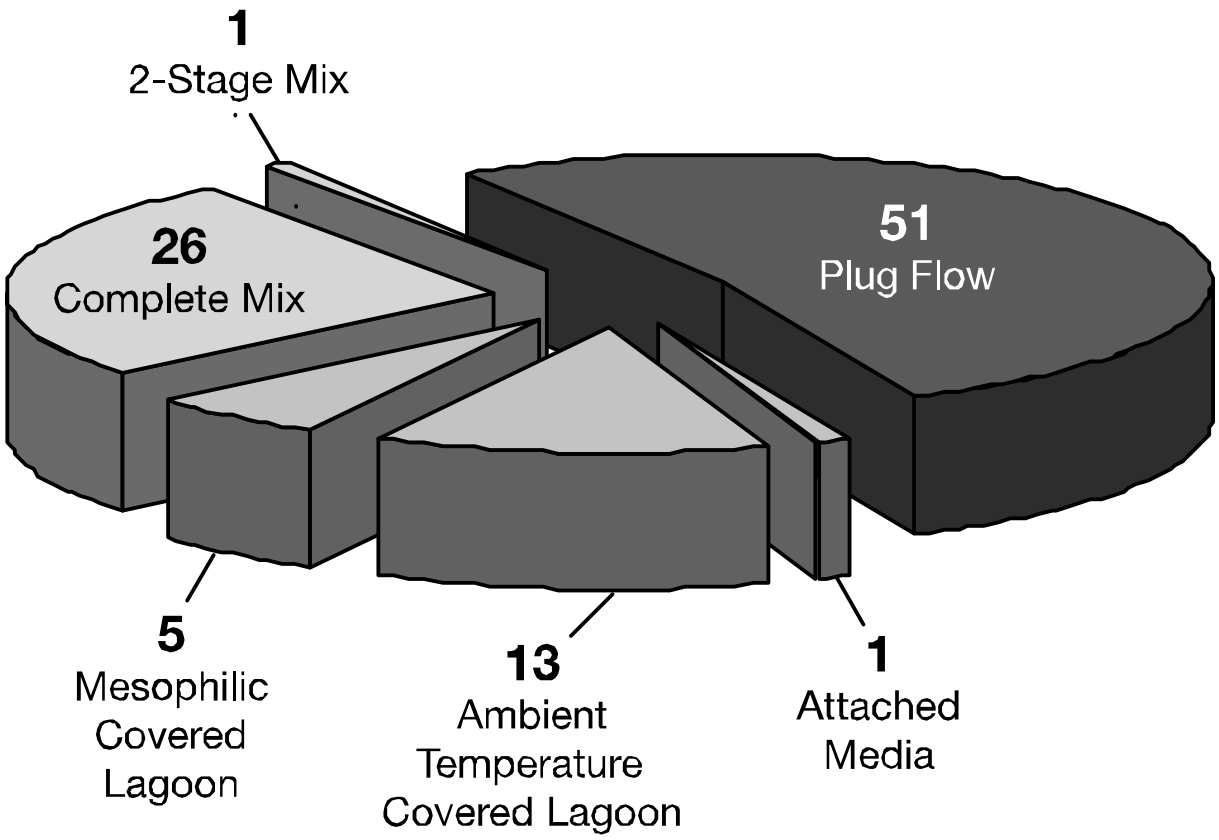
Hot Water Use

Gas Use: Flares

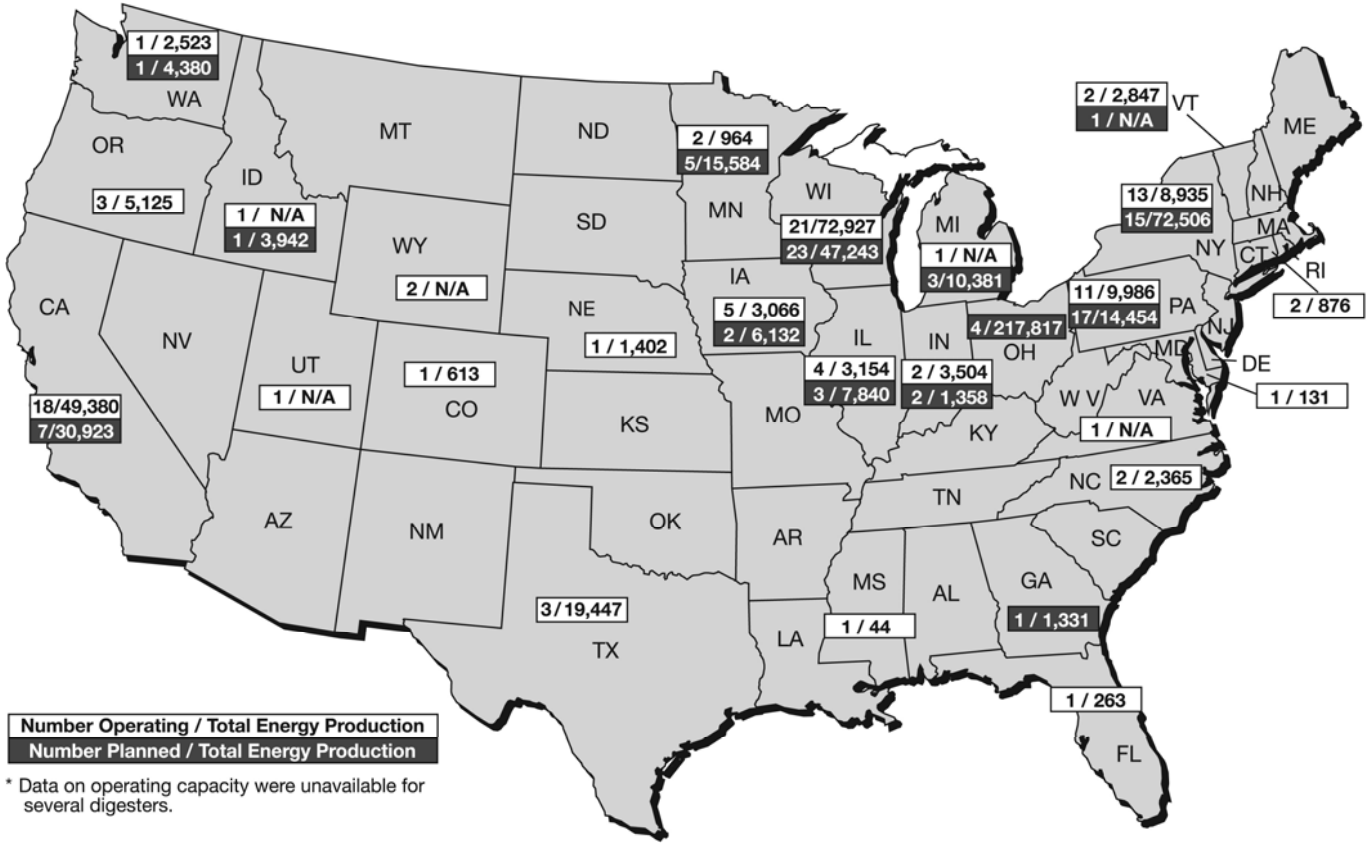
Odor Control and Greenhouse Gas Mitigation

U.S. Status 2005

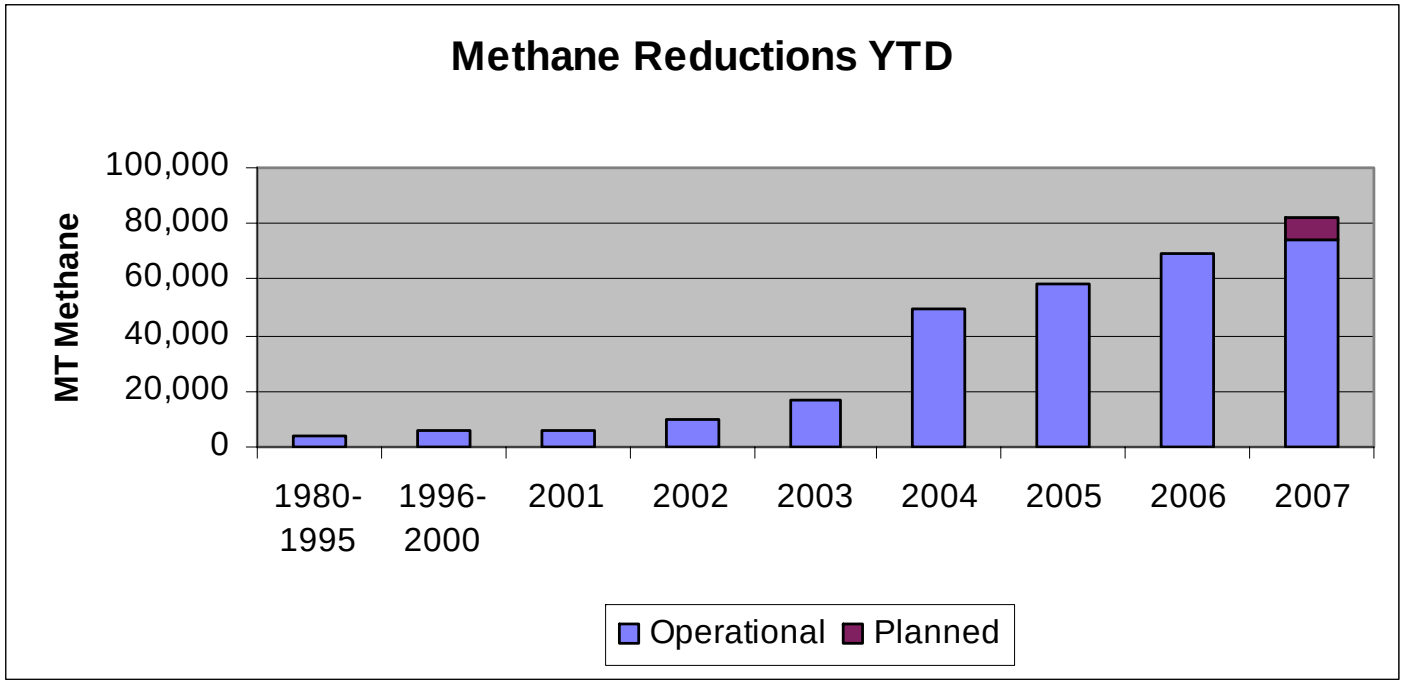
Figure 2. Operating anaerobic digesters by technology*.



National Perspective



US Livestock Methane Reduction

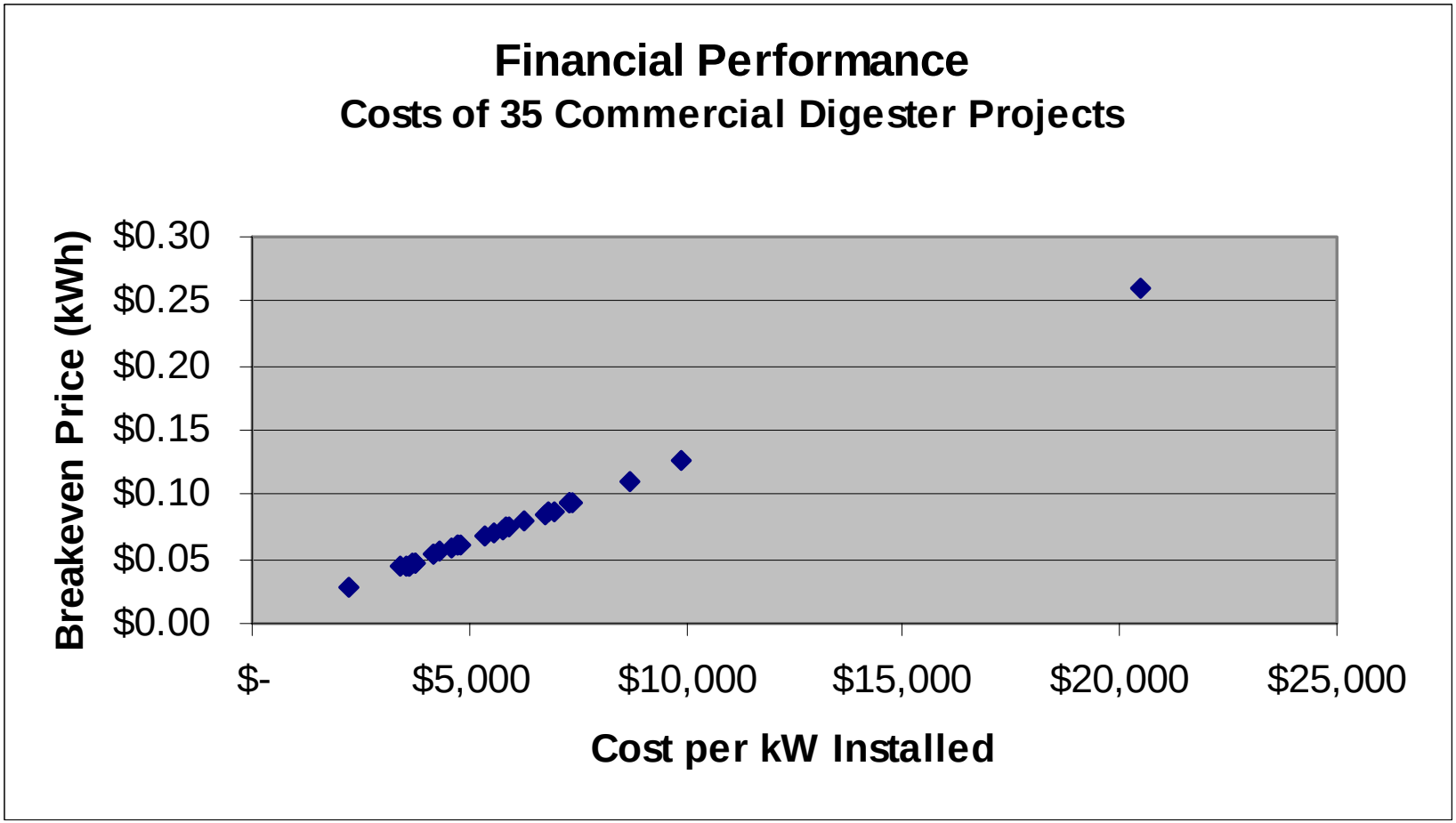


In 2006

All 'operating' projects ~275 million kWh equivalent.

~200 total projects: ~135 operating or in start-up and ~65 planned or in construction.

Digester Economics

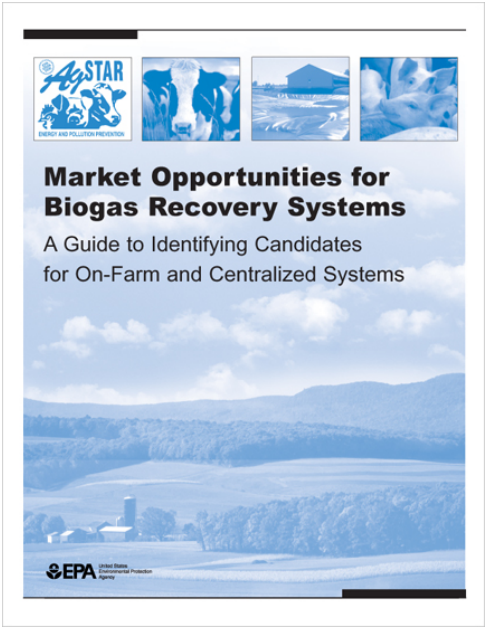


Today's Trends: Policy

- **Energy**
  - Net Metering Legislation – state by state
    - New York, Pennsylvania, California in development
  - Green Pricing Programs
    - WE Energies, Wisconsin
    - Cow Power, Vermont
- **Farm Bill**
  - Energy Title; Section 9006; "Renewable Energy and Energy Efficiency"
    - Primary funding source for "proven technologies"
- **Greenhouse Gas Markets**
  - Two farms receiving payments for reductions
  - California Climate Action Registry
- **Regulatory**
  - Water and air concerns are increasing at local, state, and federal levels

Top States and Opportunities

State	Number of Candidate Farms	Potential Methane Emissions Reduction (000 Tons)	Methane Production Potential (million ft3/year)	Electricity Generation Potential (000 MWh/year)
SWINE FARMS				
NORTH CAROLINA	1,179	247	11.5	766
IOWA	1,022	126	10.2	677
MINNESOTA	429	40	3.5	234
OKLAHOMA	52	54	2.9	196
ILLINOIS	267	36	2.8	184
MISSOURI	200	53	2.7	177
INDIANA	234	28	2.2	145
NEBRASKA	148	25	2.0	134
KANSAS	91	29	1.6	109
TEXAS	13	21	1.1	75
Remaining 40 States	646	113	7.3	487
Subtotal	**4,281**	**773**	**48**	**3,184**
DAIRY FARMS				
CALIFORNIA	963	263	18.1	1203
IDAHO	185	61	4.0	267
NEW MEXICO	123	62	3.9	259
TEXAS	149	32	2.3	154
WISCONSIN	175	8	2.1	138
NEW YORK	157	6	2.0	132
ARIZONA	73	35	1.9	126
WASHINGTON	122	22	1.9	126
MICHIGAN	72	6	1.9	73
MINNESOTA	60	3	0.7	46
Remaining 40 States	544	75	9.4	624
Subtotal	**2,623**	**573**	**48**	**3,148**
U.S. Total	**6,904**	**1,346**	**96**	**6,332**



Remember……

- Solar energy when the sun shines
- Wind energy when the wind blows
- Hydro energy when it rains

BUT, MANURE DOESN'T STOP……

Biogas energy all the time!
www.epa.gov/agstar

Thank you!